

REMARKS

The rejection of the claims as obvious from the art is respectfully traversed.

Before considering the specific art as applied by the Examiner, a brief review of the presently pending claims would be useful for explaining the differences with the prior art.

Claim 1, the sole independent claim is directed to the following combination:

- A) An on-wafer monitoring system capable of measuring an operation of a plasma treatment apparatus on a wafer, said system comprising:
 - B) one or a plurality of sensor sections,
 - C) a power source unit, and
 - D) an I/O unit that inputs/outputs signals from/to outside,
 - E) provided on a silicon substrate, wherein
 - F) said each of sensor sections has a pattern portion consisting of a SiO₂ layer which is a plasma treatment target; and
 - G) under said pattern portion, of a plurality of electrodes for separating ions and electrons of plasma by energy; and
 - H) an uppermost electrode of said electrodes has the same potential as that of said silicon substrate, wherein
 - I) a plurality of pores of predetermined size are formed going through both said pattern portion and said plurality of electrodes, and
 - J) a sensor formed at the bottom of the sensor section,

K) wherein said power source unit takes out power from plasma potential or takes out power from photoelectromotive force of a PLZT device.

Claim 2 is dependent on claim 1, and adds the following feature:

L) wherein a plurality of electrodes of said sensor sections are Al electrodes, and space between each of the Al electrodes is insulated by $\gamma\text{-Al}_2\text{O}_3$.

Claim 13 is dependent on claim 2 and adds the following feature:

U) wherein the side surface of said Al electrodes is covered with a thin oxide film.

Claim 5 which is dependent on claim 13 adds the following feature:

M) wherein said I/O unit inputs/outputs signals from/to outside by light.

Claim 6 which depends on claim 1 adds the following feature:

N) wherein said system includes an ion energy analyzer, which has a collector electrode at a sensor section bottom and measures ion current in the collector electrode to obtain ion energy distribution, as said sensor.

Claim 7 which also depends on claim 1 adds still another feature:

O) wherein said system includes a photon detector, which detects light made incident into a pattern by photoinducted current generated in an insulating film, as said sensor.

Claim 8 which also depends on claim 1 further specifies the following:

P) wherein said photon detector forms a metal thin film on said insulating film, and detects light having energy equivalent to or more than an energy difference between the work function of the metal and the conduction band bottom of said insulating film out of light transmitted the metal thin film

Claim 9 which also depends on claim 1 adds the following:

Q) said system includes a photon detector that detects light by a photo diode, as said sensor.

Claim 10 which also depends on claim 1 further specifies the following:

R) wherein said system includes an ion radical analyzer, which identifies radicals and ions by detecting light emission by the collision between electrons from an electron gun and radicals or ions, as said sensor.

Claim 11 which depends on claim 10 adds the following:

S) wherein said ion radical analyzer has a spectroscope for detecting light emission.

Finally, claim 12 which also depends on claim 1 adds the following:

T) wherein said system includes a probe, which detects at least one of electron current, electron energy distribution, ion current, electron temperature, electron density, and charge storage amount, as said sensor.

The Examiner, in discussing the primary '922 U.S. Patent to Ma et al. takes the position that Ma et al. teaches the following elements of claim 1:

Table I

	Claim 1	The Examiner's indications
1	A) An on-wafer monitoring system capable of measuring an operation of a plasma treatment apparatus on a wafer,	on-wafer plasma monitoring apparatus 112 (Figure 2)
2	B) one or a plurality of sensor sections, E) which are provided on a silicon substrate,	a ferroelectric(FE) capacitor 110 with antenna 114 (one or plurality of sensor sections) provided on a substrate
3	F) wherein said each of sensor sections has a pattern portion consisting of a SiO ₂ layer which is a plasma treatment target, and G) under said pattern portion, of a plurality of electrodes for separating ions and electrons of plasma by energy,	pattern portion which is a plasma treatment target and a plurality of electrodes 126, 122 with insulting film 124 between the electrodes

HAYES SOLOWAY P.C.
3450 E. SUNRISE DRIVE,
SUITE 140
TUCSON, AZ 85718
TEL. 520.882.7623
FAX. 520.882.7643

175 CANAL STREET
MANCHESTER, NH 03101
TEL. 603.668.1400
FAX. 603.668.8567

4	H) an uppermost electrode of said electrodes has the same potential as that of said silicon substrate, and	The uppermost electrode 126 has same potential as that of substrate 18 (through resistor 142, and lower vertical conductive portion 127, 128 and antenna 114 respectively)
5	J) a sensor formed at the bottom of the sensor section.	a sensor 116 formed at the bottom of the sensor section 110 and connected to probe pad 144 that can be formed through a pattern portion (e.g. Figs. 2,6,9-13 and col.6, line 36 to col.7, line 58)

However, the Examiner also acknowledges that the primary '922 patent to Ma et al. does not teach the following elements of claim 1:

Table II

	Claim 1	The Examiner's indications
1	I) wherein a plurality of pores of predetermined size are formed through both said pattern portion and said plurality of electrodes,	a plurality of pores of predetermined size formed through both pattern portion and said plurality of electrodes
2	C) a power source unit, K) wherein said power source unit takes out power from plasma potential or takes out power from photoelectromotive force of a PLZT device, and	a power source unit wherein said power source unit takes out power from plasma potential or takes out power from photo-electromotive force of a PLZT device
3	D) an I/O unit that inputs/outputs signals from/to outside,	I/O unit that input/outputs signals from to/outside
4	F) wherein said each of sensor sections has a pattern portion consisting of a SiO ₂ layer which is a plasma treatment target.	pattern portion that comprises SiO ₂

Notwithstanding, the Examiner takes the position that the missing elements are supplied by Smesny et al., Loewenhardt et al. and the newly cited U.S. Patent to Kojima et al. More particularly, the Examiner points to Smesny et al. as teaching the following elements of claim 1:

HAYES SOLOWAY P.C.
3450 E. SUNRISE DRIVE,
SUITE 140
TUCSON, AZ 85718
TEL. 520.882.7623
FAX. 520.882.7643

175 CANAL STREET
MANCHESTER, NH 03101
TEL. 603.668.1400
FAX. 603.668.8567

Table III

	Claim 1	The Examiner's indications
1	A) An on-wafer monitoring system capable of measuring an operation of a plasma treatment apparatus on a wafer,	a plasma sensing apparatus (Fig 1,2)
2	C) a power source unit, K) wherein said power source unit, takes out power from plasma potential or takes out power from photoelectromotive force of a PLZT device, and	a wafer 10 with plurality of sensors 12, a power source 16 that can use plasma photon energy and converts it to electrical energy
3	D) an I/O unit that inputs/outputs signals from/to outside	a signal acquisition and condition unit 18 with processor 20 that receives/sends signals from outside (through external control circuit 22) [column 6, line 35 to column 7, line50]

The Examiner further takes the position that the secondary reference Loewenhardt et al. teaches the following elements of claim 1:

Table IV

Claim 1	The Examiner's indications
A) An on-wafer monitoring system capable of measuring an operation of a plasma treatment apparatus on a wafer,	an apparatus for ion energy measurement during semiconductor wafer processing (Fig 1,2,4,5)
I) wherein predetermined pores going through both said pattern portion and a plurality of electrodes.	a monitoring wafer 102 with ion energy analyzers 104, and pattern portion having layers of insulation 202, 208, 214 with apertures, plurality of electrodes 206,212, 218 having pores of predetermined size (approx. 200 mils per inch) and where the measuring system enables to measure ion current and to obtain ion energy distribution (e.g. Figs 1,2,4,5 and col. 3 line 30 to col. 6, line 15)

And, the Examiner takes the position that the newly cited U.S. Patent to Kojima et al. teaches the following elements of claim 1:

HAYES SOLOWAY P.C.
3450 E. SUNRISE DRIVE,
SUITE 140
TUCSON, AZ 85718
TEL. 520.882.7623
FAX. 520.882.7643

175 CANAL STREET
MANCHESTER, NH 03101
TEL. 603.668.1400
FAX. 603.668.8567

Table V

Claim 1	The Examiner's indications
F) wherein said each of sensor sections has a pattern portion consisting of a SiO ₂ layer which is a plasma treatment target.	a method of plasma etching comprising a substrate 61 with an oxide layer 65 that is patterned to form a hole portion "A" in the oxide layer. use of etched SiO ₂ enables to achieve higher selectivity

Finally, the Examiner has taken the position that the features of dependent claims 5, 6, 9 and 12 are provided by the applied art as follows:

Table VI

	Claim	The Examiner's indications
1	<claims 5,9> M) wherein said I/O unit inputs/outputs signals from/to outside by light. Q) said system includes a photon detector that detects light by a photo diode, as said sensor.	<Smesny et al (US 5,444,637)> the test wafer includes an input probe that can receive optically transmitted information (would include photon detector) [column 5, lines 1-22]
2	<claim6> N) wherein said system includes an ion energy analyzer, which has a collector electrode at a sensor section bottom and measures ion current in the collector electrode to obtain ion energy distribution, as said sensor.	<Loewenhard et al(US 5,451,784)> the apparatus (Fig.1,2) includes a monitoring wafer 102 with ion energy analyzers 104 and where a collector electrode 200 is disposed at the bottom of the sensor section that measures ion current and enables to obtain ion energy distribution (column 3, line 30 to column 6 line 15)
3	<claim 12> T) wherein said system includes a probe, which detects at least one of electron current, electron energy distribution, ion current, electron temperature, electron density, and charge storage amount, as said sensor.	<Loewenhard et al(US 5,451,784)> probe 106 that can measure ion current (Fig 2 and column 6, lines 1-15)

It is submitted that the Examiner has mischaracterized the primary reference Ma et al. as applied to the instant claimed invention.

Considering first the rejection of claim 1, in the Final Action, the Examiner takes the position that "a plurality of electrodes 126, 122 with insulting film 124 between the electrodes" in Ma et al is equivalent to "G)under said pattern portion, of a plurality of electrodes for separating ions and electrons of plasma by energy" in claim 1 (see Table I item 3 above)

But "a plurality of electrodes 126, 122 with insulting film 124 between the electrodes" comprises FE capacitor 110 and do not operate for "separating ions and electrons of plasma by energy".

Therefore, "G)under said pattern portion, of a plurality of electrodes for separating ions and electrons of plasma by energy" of claim 1 is not disclosed in Ma et al.

The Examiner also takes the position in the final action that "the uppermost electrode 126 has same potential as that of substrate 18 (through resistor 142, and lower vertical conductive portion 127, 128 and antenna 114 respectively)" in Ma et al is equivalent to "H) an uppermost electrode of said electrodes has the same potential as that of said silicon substrate" in claim 1 (see Table I item 4 above).

But in Ma et al, there is the description that "The capacitor 10 is thus vertically disposed between the upper surface of the wafer 12, and the substrate 18 thereof, forming a capacitor charging circuit wherein the resistance of the antenna 14 and the upper and lower conductive materials 28 and 30, respectively are serially connected with the FE capacitor 10 between the upper surface of the wafer 12 and the substrate 18" (see column 6 lines 54-60).

HAYES SOLOWAY P.C.
3450 E. SUNRISE DRIVE,
SUITE 140
TUCSON, AZ 85718
TEL. 520.882.7623
FAX. 520.882.7643

175 CANAL STREET
MANCHESTER, NH 03101
TEL. 603.668.1400
FAX. 603.668.8567

Therefore, "the substrate 118" is connected to "the bottom electrode 122", and, therefore Ma et al does not disclose "H) an uppermost electrode of said electrodes has the same potential as that of said silicon substrate" of claim 1.

Furthermore, this is in relation to "G) under said pattern portion, of a plurality of electrodes for separating ions and electrons of plasma by energy" discussed above.

The Examiner also states in the final action that "a sensor 116 formed at the bottom of the sensor section 110 and connected to probe pad 144 that can be formed through a pattern portion"(e.g. Figs. 2, 6, 9-13 and col.6, line 36 to col.7, line 58) corresponding to "J) a sensor formed at the bottom of the sensor section"(see Table I item 5 above)

But "the sensor section" of claim 1 has two parts. One part is "F) a pattern portion consisting of a SiO₂ layer which is a plasma treatment target", and the other part is "G) under said pattern portion, of a plurality of electrodes for separating ions and electrons of plasma by energy."

In claim 1, F) and G) compose "the sensor section," under the two part of "the sensor section," there is a "sensor."

However, the "metal layer 116" described in Ma et al is only a connection, not a "sensor."

Claim 1 determines only the location of a sensor in the on-wafer monitoring system, and does not determine the specific sensor.

Therefore, Ma et al does not disclose "F) pattern portion consisting of a SiO₂ layer which is a plasma treatment target" or "G) under said pattern portion, of a plurality of electrodes for separating ions and electrons of plasma by energy."

Thus, it is submitted that the primary reference Ma et al. has several differences.

It is not seen that any of the secondary references alone or in combination can be said to supply the missing teachings to May et al. to achieve or render obvious claim 1. As discussed in Amendment D, the contents of which are incorporated by reference, the secondary reference Smesny et al. does not teach a pattern portion and plurality of electrodes having pores of predetermined size formed therein. Nor is this missing teaching is supplied by Loewenhardt et al. Even assuming arguendo Loewenhardt et al. is as the Examiner states, there is nothing within the four corners of Loewenhardt et al. that teaches or suggests that the pattern portion comprise an SiO₂ layer as required by Applicants' claim 1. Nor is there any teaching or suggestion within the four corners of Loewenhardt et al. of a plurality of electrodes for separating ions and electrons of plasma by energy, under a pattern portion as required by Applicants' claim 1. As pointed out in the paragraph bridging pages 9-10 of Applicants' specification, forming the patterns in an SiO₂ layer permits measuring voltage and current characteristics in a high-aspect pattern. Thus, providing a pattern portion in an SiO₂ layer as required by Applicants' claimed invention is more than merely academic and provides significant technical advantages.

The newly cited U.S. Patent to Kojima et al. also fails to supply the more basic teachings to Ma et al. to achieve or render obvious claim 1 alone or in combination with the several other applied references. Accordingly, even assuming arguendo the newly cited patent to Kojima et al. is as the Examiner states, it is submitted that it still would not be obvious to one skilled in the art to combine the prior art references as applied by the Examiner to achieve claim 1. Indeed, the Examiner has cherry picked from four different references to make out a case for obviousness. It is submitted that this is a classic case of unbridled hindsight

HAYES SOLOWAY P.C.
3450 E. SUNRISE DRIVE,
SUITE 140
TUCSON, AZ 85718
TEL. 520.882.7623
FAX. 520.882.7643

175 CANAL STREET
MANCHESTER, NH 03101
TEL. 603.668.1400
FAX. 603.668.8567

reconstruction where the Examiner has used Applicant's claims as a template, and has cherry picked from several prior art references to make out a case for obviousness.

Accordingly, it is submitted that claim 1 and claims 5, 6, 9 and 12 which are dependent thereon cannot be said to be obvious from Ma et al.'s '922 in view of Smesny et al., Loewenhardt et al. and Kojima et al.

Turning to the rejection of claims 5, 6, 9 and 12, all of these claims depend directly or indirectly on claim 1. The deficiencies of the primary reference May et al. '922 are discussed above. It is not seen that any of the secondary references alone or in combination achieve or render obvious claim 1, or claims 5, 6, 9 and 12 which depend thereon.

Turning to the rejection of claim 2 as obvious from the above combination Ma et al., Smesny et al., Loewenhardt et al. and Kojima et al. and further in view of Ma et al.'s '636, and the rejection of claim 7 and 8 as obvious from the above combination in view of Toyoda et al., and the rejection of claims 10 and 11 as obvious from the above combination in view of Pinnaduwege, and the rejection of claim 13 as obvious from the above combination in view of Ma et al.'s '636 and further in view of Johnson et al., it is submitted that none of the additional applied references supply the basic missing teachings to the primary reference Ma et al. '922 taken alone or in combination with Smesny et al., Loewenhardt et al. and Kojima et al.

A specific sensor is defined in Claim 6 (ion energy analyzer), in Claims 7-9 (photon detector), Claim 10 (ion radical analyzer), Claim 11 (spectroscope), claim 12 (probe to detect at least one of electron current, electron energy distribution, ion current, electron temperature, electron density, and charge storage amount).

HAYES SOLOWAY P.C.
3450 E. SUNRISE DRIVE,
SUITE 140
TUCSON, AZ 85718
TEL. 520.882.7623
FAX. 520.882.7643

175 CANAL STREET
MANCHESTER, NH 03101
TEL. 603.668.1400
FAX. 603.668.8567

As can be seen from Table VII below, none of these secondary references alone or in combination with Ma et al. '922 and the several other references can be said to achieve or render obvious claim 1 or any of the claims which depend directly or indirectly thereon.

HAYES SOLOWAY P.C.
3450 E. SUNRISE DRIVE,
SUITE 140
TUCSON, AZ 85718
TEL. 520.882.7623
FAX. 520.882.7643

175 CANAL STREET
MANCHESTER, NH 03101
TEL. 603.668.1400
FAX. 603.668.8567

Table VII

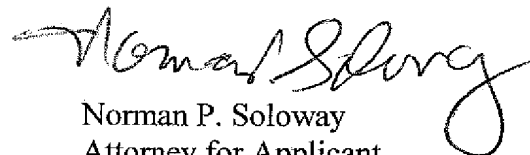
	Claim	The Examiner's indications
1	<Claim 2> L) wherein a plurality of electrodes of said sensor sections are Al electrodes, and space between each of the Al electrodes is insulated by γ - Al_2O_3 .	<Ma(US 6,673,636)> an apparatus (Fig. 5-7) for real time measurement of plasma parameters and comprising of a silicon substrate 601 provided with an aluminum electrode 604 in a patterned portion of a resist layer and where there is an insulator layer 603 of aluminum oxide (Al_2O_3) provided between substrate and the electrode 604. Further, it is known in the art to use anodization, that is, aluminum oxide (γ - Al_2O_3) as insulating layer over silicon wafers (column 3, line 1 to column 4, line 20 and column 5, line 1 to column 6, line 65).
2	<Claim 7> O) wherein said system includes a photon detector, which detects light made incident into a pattern by photoinduced current generated in an insulating film, as said sensor	<Toyoda (US 6,462,328)> an apparatus (Fig.5) that includes photosensors Dr, Dc that detect light after passing through silicon oxide (insulating film) 40, 38, 25 and where the electric current is proportional to the amount of incident light (column 5, line 38-58)
3	<Claim 8> P) wherein said photon detector forms a metal thin film on said insulating film, and detects light having energy equivalent to or more than an energy difference between the work function of the metal and the conduction band bottom of said insulating film out of light transmitted the metal thin film.	<Toyoda (US 6,462,328)> photo sensor includes an aluminum film (metal film) 42a formed on the oxide film 40 that helps to avoid scattering light reaching the light receiving sensor portions. Further, the dependence of light detected on the work function difference is a functional aspect that would depend upon the type of material selected for the metallic and the oxide coating and other related parameters.
4	<Claim 10> R) wherein said system includes an ion radical analyzer, which identifies radicals and ions by detecting light emission by the collision between electrons from an electron gun and radicals or ions, as said sensor.	<Pinnaduwege (US 5,896,196)> an apparatus (Figs.1-3) where a glow discharge apparatus 10 has an analysis region 22 in which an electron beam is introduced from electrode 14 (electron gun) and positive and negative ions can be identified using optical spectrometer 54. typically in prior art an electron gun is used as a source of electrons that collide with gas particles (column 1, line 10 to column 32, line 30).

5	<Claim 11> S) wherein said ion radical analyzer has a spectroscope for detecting light emission	<Pinnaduwege (US 5,896,196)> an apparatus (Figs 1-3) where a glow discharge apparatus 10 has an analysis region 22 in which an electron beam is introduced from electrode 14 (electron gun) and positive and negative ions can be identified using optical spectrometer 54. Pinnaduwege also teaches that typically in prior art an electron gun is used as a source of electrons that collide with gas particles (column 1, line 10 to column 32, line 30).
6	<Claim 13> U) wherein the side surface of said Al electrodes is covered with a thin oxide film.	<Johnson et al(US 2004/00211094)> an apparatus (Figures 2-5) that includes a monitoring wafer 12 with a substrate 20 that has aluminum ion current collectors (electrodes) 26 that have an anodized (covered with thin oxide film) cylindrical surface (e.g.Figs.2-5 and para. 0039, 0040).

Thus, none of the claims can be said to be obvious from the applied art.

The foregoing Amendment makes no claim changes that would require further search by the Examiner. Accordingly, entry of the foregoing Amendment, and allowance of the application are respectfully requested.

Respectfully submitted,



Norman P. Soloway
Attorney for Applicant
Reg. No. 24,315

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HAYES SOLOWAY P.C.
3450 E. SUNRISE DRIVE,
SUITE 140
TUCSON, AZ 85718
TEL. 520.882.7623
FAX. 520.882.7643

175 CANAL STREET
MANCHESTER, NH 03101
TEL. 603.668.1400
FAX. 603.668.8567